# Consistency of Estimated Global Water Cycle Variations Over the Satellite Era

Abstract

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Motivated by the question of whether recent indications of decadal climate variability and a possible “climate shift” may have affected the global water balance, we examine evaporation minus precipitation (E-P) variability integrated over the global oceans and global land from three points of view—remotely sensed retrievals / objective analyses over the oceans, reanalysis vertically-integrated moisture convergence (MFC) over land, and land surface models forced with observations-based precipitation, radiation and near-surface meteorology. Because monthly variations in area-averaged atmospheric moisture storage are small and the global integral of moisture convergence must approach zero, area-integrated E-P over ocean should essentially equal precipitation minus evapotranspiration (P-ET) over land (after adjusting for ocean and land areas).

Our analysis reveals considerable uncertainty in the decadal variations of ocean evaporation when integrated to global scales. This is due to differences among datasets in 10m wind speed and near-surface atmospheric specific humidity (2m $q_a$) used in bulk aerodynamic retrievals. Precipitation variations, all relying substantially on passive microwave retrievals over ocean, still have uncertainties in decadal variability, but not to the degree present with ocean evaporation estimates. Reanalysis MFC and P-ET over land from several observationally forced diagnostic and land surface models agree best on interannual variations. However, upward MFC (i.e. P-ET) reanalysis trends are likely related in part to observing system changes affecting atmospheric assimilation models. While some evidence for a low-frequency E-P maximum near 2000 is found, consistent with a recent apparent pause in sea-surface temperature (SST) rise, uncertainties in the datasets used here remain significant.

Prospects for further reducing uncertainties are discussed. The results are interpreted in the context of recent climate variability (Pacific Decadal Oscillation, Atlantic Meridional Overturning), and efforts to distinguish these modes from longer-term trends.

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